

Part II. Overview of September 2002 DAG-TM Experiment

- **Experiment objectives**
- **Terminology & key concepts**
- **Airspace & traffic flows**
- **Basic DAG scenario**
- **Notes on use of RTA in DAG September 2002 Study**
- **Arrival chart, approach charts & Precision Descent**
- **Test plan**
- **Flight deck & ATC automation**
- **Daily schedule**

- **Evaluate interim DAG-TM operational concepts & automation**
 - for trajectory negotiation (CE-6)
 - for supporting en route free maneuvering (CE-5)
 - for in trail self-spacing in TRACON (CE-11)
 - for managing arrival traffic
- **Obtain controller and pilot feedback about concepts, adequacy of scenarios and experimental design**

Related to control status and communication:

Autonomous aircraft: (or “unmanaged or “free flight” aircraft) Flight crew is responsible for maintaining separation from other aircraft, and may initiate trajectory changes without ATC approval. Autonomous aircraft must be CDTI, CD&R, and RTA equipped, and flight crews must follow “rules of the road” for conflict resolution.

Managed aircraft: All trajectory changes must be ATC approved, and ATC is responsible for separation. Managed aircraft may be CDTI equipped or not.

Equipped aircraft: FMS+SPACING+ADS-B+CPDLC+intent+RTA+CDTI+CD&R

Unequipped aircraft: FMS+SPACING+ADS-B+CPDLC+intent+RTA+CDTI

“Rules of the Road”: Right-of-Way rules for resolving conflicts that involve at least one autonomous aircraft.

Intent:

Cockpit Display of Traffic Information (CDTI):

Conflict Detection & Resolution capability (CD&R):

Data Link: Digital communication system for air-ground information exchange

ADS-B: “Automatic Dependent Surveillance, Broadcast” -- automatic datalink broadcast of aircraft state information (e.g., heading, airspeed, altitude, route).

Controller-Pilot Data Link Communication (CPDLC): data link that supports air-ground clearance and request communications between pilots and controllers.

Related to time-based metering:

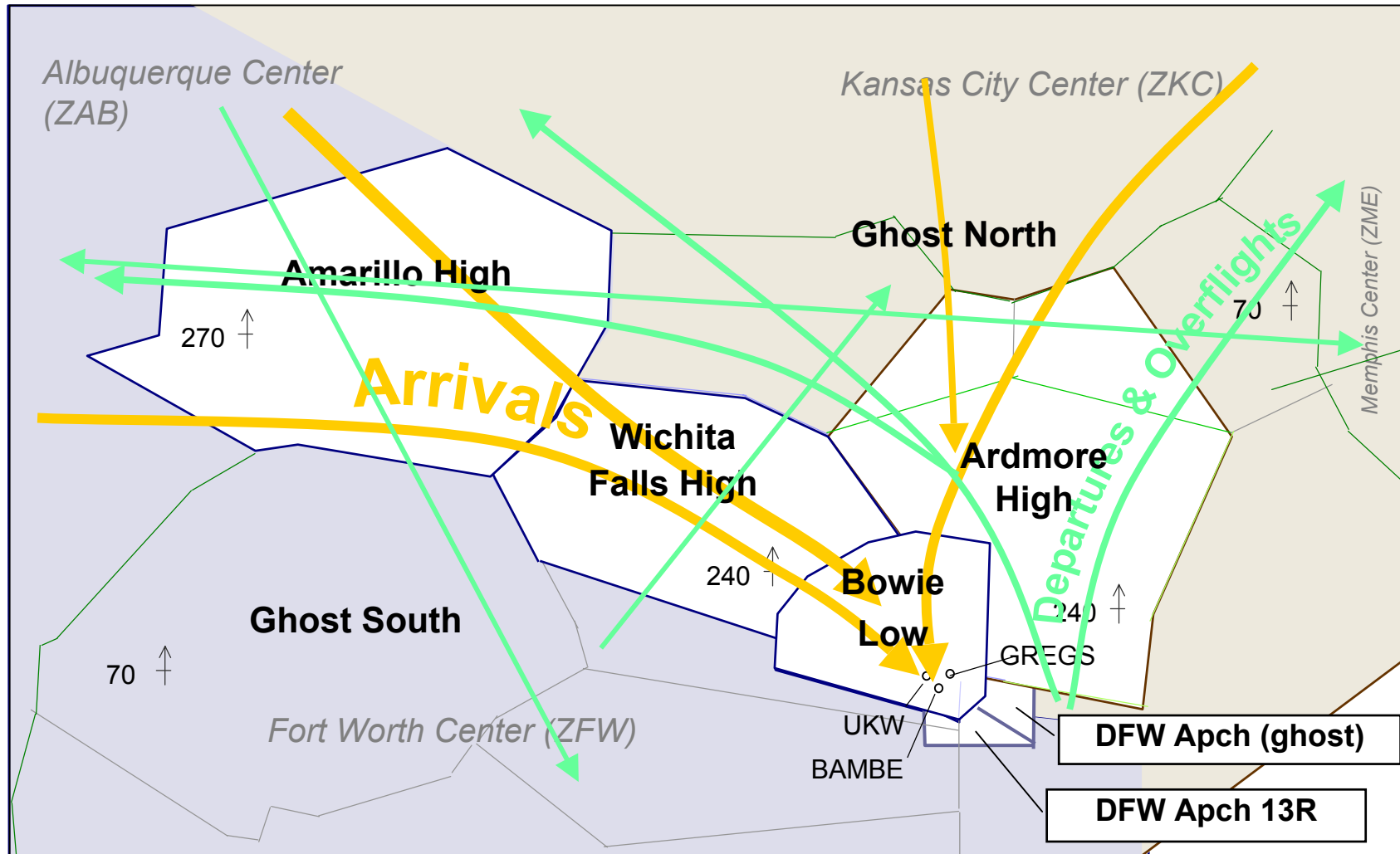
Estimated Time of Arrival (ETA): The time at which an arrival aircraft is estimated to cross the BAMBE meter fix if it conforms with its broadcast FMS trajectory.

Scheduled Time of Arrival (STA): The time that the Traffic Management Advisor schedules an aircraft to cross the meter fix.

Required Time of Arrival (RTA): A meter fix arrival time assigned to an autonomous aircraft.

Traffic Management Advisor (TMA): CTAS automation process that creates a 'first-come, first-served' meter fix schedule for arrival aircraft. The TMA scheduler is also set-up to provide a minimum of 7 miles-in-trail spacing at the meter fix. At BAMBE, with an 11,000 foot and 250 knot crossing restriction, this translates to roughly 82 seconds minimum spacing between aircraft.

Precision Descent:



Pilots of **autonomous aircraft** use CDTI tools and '**rules-of-the-road**' to resolve traffic conflicts and plan **RTA** compliant descents into controlled airspace. All changes are broadcast. **(CE-5 only)**

High altitude controllers use CTAS tools (**TMA**, conflict probe) to monitor en route & arrival aircraft.

Controller reviews downlinked trajectory change request from **managed aircraft**. If acceptable, uplink response clears aircraft to fly requested trajectory.

At the freeze horizon, CTAS **TMA** generates a final schedule of meter fix arrival times (**RTAs** & **STAs**) for arriving aircraft.

Controllers use CTAS tools to monitor and fine tune the arrival plan. They may issue cruise and descent speeds and route changes by voice or datalink to **managed aircraft**. These clearances override the **STA** advisory.

Pilots of **managed (and equipped) aircraft** may use CDTI tools to resolve traffic conflicts and plan **STA**-advisory compliant descents. Route changes are downlinked to ATC for approval. Speed changes *do not* require ATC approval. All changes are broadcast.

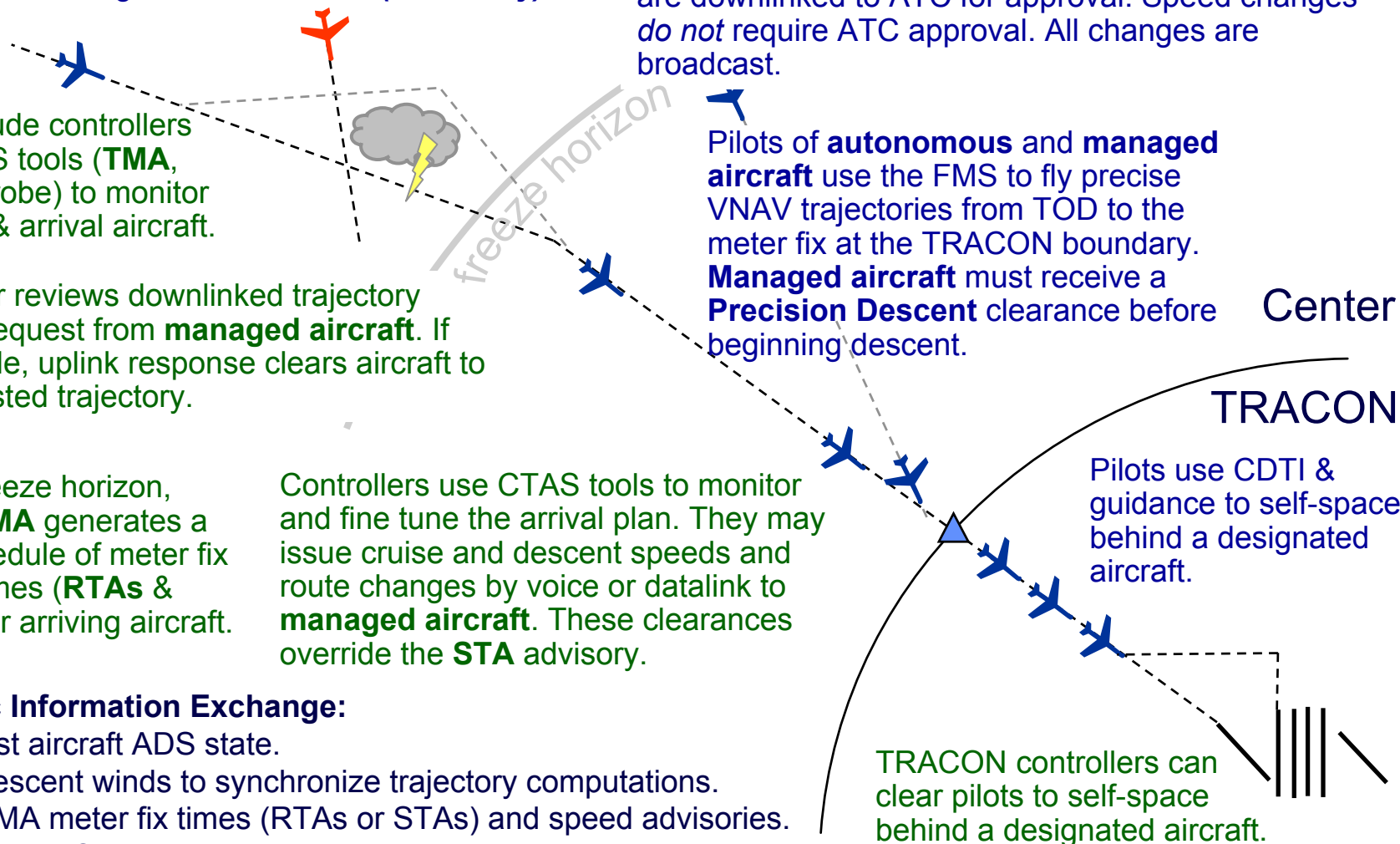
Pilots of **autonomous and managed aircraft** use the FMS to fly precise VNAV trajectories from TOD to the meter fix at the TRACON boundary. **Managed aircraft** must receive a **Precision Descent** clearance before beginning descent.

Pilots use CDTI & guidance to self-space behind a designated aircraft.

TRACON controllers can clear pilots to self-space behind a designated aircraft.

Automatic Information Exchange:

- Broadcast aircraft ADS state.
- Uplink descent winds to synchronize trajectory computations.
- Uplink TMA meter fix times (RTAs or STAs) and speed advisories.
- Broadcast FMS trajectory whenever it changes.



- **Arrival aircraft will receive one or two automatic uplinks providing either an STA or an RTA at the meter fix:**
 - **The first uplink (a preliminary STA) is sent when the aircraft is 220 miles or more from the meter fix.**
 - **The second uplink (the final STA) is sent when the aircraft crosses the freeze horizon, 160 nm from the meter fix.**
- **For managed aircraft both uplinks provide advisory information about the ATSP's scheduled time of arrival (STA) at the meter fix.**
- **For autonomous aircraft the first uplink provides an advisory STA, the second uplink provides a required time of arrival (RTA).**

D-ATIS 123.77

REGIONAL Approach (R)	119.87	133.62
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BORGER
D
(L) 108.6 BGD
N35 48.4 W101 22.9

PANHANDLE
 (D) 116.6 PNH
 N35 14.1 W101 41.9

TULSA
D
(H) 114.4 TUL
N36 11.8 W095 47.3

BOWIE SEVEN ARRIVAL
(UKW.UKW7)

JETS
Prepare to be reassigned the Masti
STAR by ATC in lieu of this STAR.

NOT TO SCALE

GUTHRIE
D 114.5 GTH
(L)
N33 46.7 W100 20.2

JETS
EXPECT to cross
at **FL 240.**

Landing South:
Cross at and
maintain 250 KIAS
EXPECT to cross at
11000'.

HIKAY
N33 10.6 W097 26.6

Landing South:
EXPECT vectors to
final approach course

ANGER
15.7 FUZ
... ..
4 W097 10.8

MAVERICK
D
(H) 113.1 TTT
N32 52.1 W097 02.4

ARRIVAL NOTES:

1. Precision Descent Clearance

- "Precision descent at YYY knots."
- This is a clearance to descend at the VNAV top-of-descent
- Vertical navigation is not at pilot's discretion.
- Maintain current altitude until reaching the VNAV Top-of-descent.
- Maintain cruise mach in descent until reaching the cleared descent speed of YYY knots.
- Unless otherwise specified cross BAMBE at 11.000 feet and 250 knots.

2. Free Flight Aircraft

- Unless otherwise specified cross BAMBE at 11,000 feet and 250 knots on the UKW7 arrival at the assigned time.

ABILENE
D
(H) 113.7 ABI
N32 28.9 W099 51.8

MILLSAP
D
(H) 117.7 MQP
N32 43.6 W097 59.1

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CHANGES: See other side.

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Normal clearance:

"Cleared for a precision descent at YYY knots."

Expected pilot behavior:

On receipt of the precision descent clearance the pilot is expected to check that the BAMBE crossing restriction is 11,000 feet and 250 knots, enter 0.XX/YYY on the VNAV descent page, lower the MCP altitude to 11,000 feet and engage VNAV. (0.XX is the cruise Mach.)

Clearance with an altitude limit:

"Cleared for a precision descent at YYY knots except maintain flight level 240."

Expected pilot behavior:

On receipt of the precision descent clearance the pilot is expected to check that the BAMBE crossing restriction is 11,000 feet and 250 knots, enter 0.XX/YYY on the VNAV descent page, lower the MCP altitude to 24,000 feet and engage VNAV. (0.XX is the cruise Mach.)

Controller expectations for a normal precision descent clearance:

- Aircraft will maintain current lateral routing
- Aircraft will maintain cruise altitude and Mach until its VNAV top of descent.
- Aircraft will initiate descent at its VNAV top-of-descent point.
- Aircraft will descend at cruise Mach until reaching the assigned descent speed and then maintain the assigned descent speed.
- Aircraft will maintain assigned descent speed within plus/minus 10 knots.
- Aircraft will cross BAMBE at 11,000 feet and 250 knots.

KDFW ILS Rwy 13R & 18R Approach Charts

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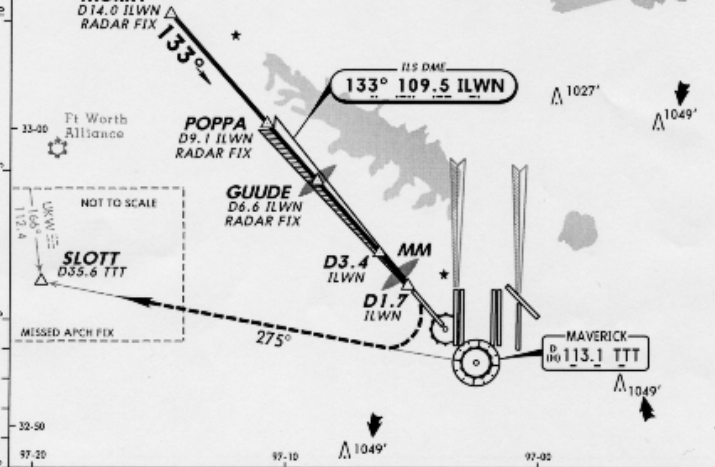
Notice: After 3/22/01 0901Z this chart should not be used without first checking JeppView or NOTAMs.

KDFW
DALLAS-FT WORTH INTL 4 FEB 00 (61-1) ILS Rwy 13R

D-ATIS Arrival	REGIONAL Approach (R)	West	DFW Tower	East	West	Ground	East
123.77	133.15 118.1	124.15 134.9	126.55 127.5	121.85	121.65 121.8		
LOC ILWN 109.5	Final Apch Crs 133°	GS GUUDE 2235' (1644')	ILS DA(H) 791' (200')	Apch Elev 603'	TDZE 591'		

MISSED APCH: Climb to 1000' then climbing RIGHT turn to 5000' outbound via TTT VOR R-275 to SLOTT INT/D35.6 TTT.

RADAR required. MSA TTT VOR



GS	70	90	100	120	140	160	MALSR	1000'	5000'	TTT	SLOTT
GS	3.00°	377	485	539	647	754	862				
MAP at D1.7 ILWN or GUUDE to MAP	4.9	4:12	3:16	2:56	2:27	2:06	1:50				

ILS	LOC (GS out)	LOC (GS out)	LOC (GS out)
DA(H) 791' (200')	MDA(H) 960' (369') With D3.4 ILWN	MDA(H) 1100' (509') Without D3.4 ILWN	

FULL	TDZ or CL out	RAIL or ALS out	RAIL out	ALS out	ILWN 24 or 1/2	RAIL out	ALS out
RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 1/4	RVR 24 or 1/2	RVR 40 or 1/4	RVR 50 or 1	RVR 40 or 1/4	RVR 50 or 1
						RVR 50 or 1	1 1/2

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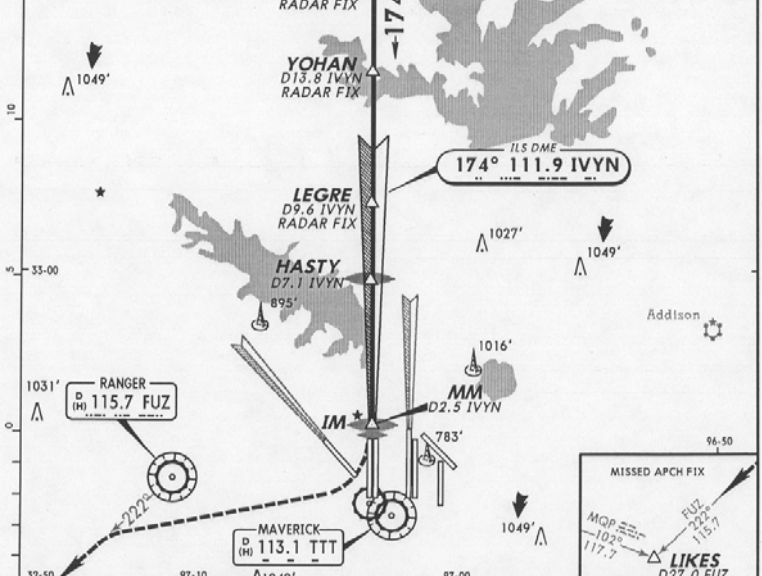
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KDFW
DALLAS-FT WORTH INTL 12 APR 02 (61-10) ILS Rwy 18R

D-ATIS Arrival	REGIONAL Approach (R)	West	DFW Tower	East	West	Ground	East
123.77	118.42	124.15 134.9	126.55 127.5	121.85	121.65 121.8		
LOC IVYN 111.9	Final Apch Crs 174°	GS HASTY 2307' (1704')	ILS DA(H) 803' (200')	Apch Elev 603'	TDZE 18R 603'		

MISSED APCH: Climbing RIGHT turn to 5000' outbound via FUZ VOR R-222 to LIKES INT/D27.0 FUZ.

1. RADAR required. 2. Simultaneous approach authorized with Rwy 17L/C/R. MSA TTT VOR



GS	70	90	100	120	140	160	MALSR	1000'	5000'	TTT	LIKES
GS	3.00°	377	484	538	646	753	861				
MAP at D2.5 IVYN or HASTY to MAP	4.6	3:57	3:04	2:46	2:18	1:58	1:44				

ILS	LOC (GS out)	LOC (GS out)	LOC (GS out)
DA(H) 803' (200')	MDA(H) 1220' (617')	MDA(H) 1220' (624')	

FULL	TDZ or CL out	ALS out	RAIL out	ALS out	ILWN 24 or 1/2	RAIL out	ALS out
RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 1/4	RVR 24 or 1/2	RVR 40 or 1/4	RVR 50 or 1	RVR 40 or 1/4	RVR 50 or 1
						RVR 50 or 1	1 1/2

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HIKAY 13R & 18R FMS Transitions

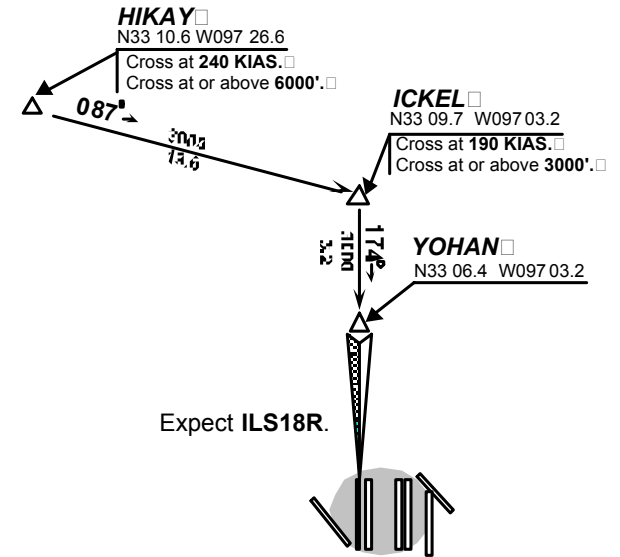
HIKAY 18R (HIK18R) FMS Transition

	distance	altitude	speed
BAMBE	50.7nm	11,000'	250
KAGLE	41.7nm	-----	---
HIKAY	34.6nm	6,000'	240
ICKEL	15.0nm	3,000'	190
YOHAN	11.8nm	3,000'	170
HASTY	5.2nm	2,200'	150
18R	0.0nm	591'	---

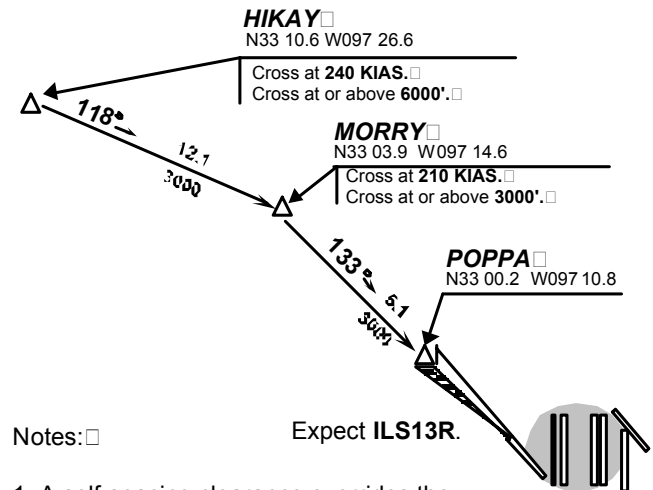
HIKAY 13R (HIK13R) FMS Transition

	distance	altitude	speed
BAMBE	41.1nm	11,000'	250
KAGLE	32.1nm	-----	---
HIKAY	25.0nm	6,000'	240
MORRY	12.9nm	3,000'	210
POPPA	7.9nm	3,000'	170
GUUDE	5.4nm	2,200'	150
13R	0.0nm	591'	---

HIKAY 18R (HIK18R) FMS TRANSITION



HIKAY 13R (HIK13R) FMS TRANSITION



Notes:

1. A self-spacing clearance overrides the charted speeds.

2. A spacing clearance.

- **Purpose**
 - Compare 2 en route concepts — free maneuvering & trajectory negotiation — to baseline
 - Compare TRACON concept — in trail self-spacing — to baseline
- **Airspace**
 - *Northwest section of Fort Worth Center, DFW TRACON*
- **Controllers**
 - 4 FPL en route, 1 TRACON & 3 ‘cohort’ controllers
- **Pilots**
 - 6 commercial airline pilots flying CDTI-equipped PC-based aircraft simulators
 - 2 commercial airline pilots flying CDTI-equipped full-mission flight deck simulator
 - 7 ‘cohort’ pilots flying multi-aircraft simulator workstations
- **Traffic Scenario**
 - 3 equivalent scenarios
 - ~ 90 aircraft including 45 arrivals from the west and north arriving at the northwest ZFW cornerpost within approximately 1 hour
- **Aircraft capability**
 - Equipped aircraft: FMS+SPACING+ADS-B+CPDLC+intent+RTA+CDTI+CD&R
 - Unequipped aircraft: FMS+SPACING+ADS-B+CPDLC+intent+RTA+CDTI
- **Exp Design**
 - (Center) 3 test conditions x 2 repetitions
 - (TRACON) 2 test conditions x 2 repetitions
- **Metrics**
 - throughput - efficiency - workload - acceptability - situation awareness

Flight Deck Tools & Procedures	Baseline	CE 6 & 11 Trajectory Negotiation		CE 5 & 11 Free Maneuvering	
	<i>All Aircraft</i>	<i>Unequipped</i>	<i>Equipped</i>	<i>Unequipped</i>	<i>Equipped</i>
Flight Management System (FMS)	x	x	x	x	x
Cockpit display of traffic information (CDTI)	x	x	x	x	x
ADS-B	x	x	x	x	x
Conflict detection & resolution capability (CD&R)			x		x
Route planning			x		x
Controller-pilot data link (CPDLC)		x	x	x	x
Precision Descent Procedures		x	x	x	x
Self-spacing capability		x	x	x	x
Rules of the Road					x
RTA capability		x	x	x	x
ATC Tools & Procedures	Baseline	CE 6 & 11 Trajectory		CE 5 & 11 Free Maneuvering	
TMA	x	x		x	
Descent Advisory		x		x	
Conflict detection		x		x	
Trial planning		x		x	
Arrival spacing capability		x		x	
Control exchange capability				x	
Rules of the Road				x	

- *2 days of training*
- *6 days data collection*
- *Daily schedule for data collection days (Days 3-8):*

8:00-8:30AM: Morning Briefing, Room 100

8:45-10:00AM: Run #1

10:00-10:15AM: BREAK

10:30-12:00PM: Run #2

12:00-1:00PM: LUNCH

1:15-2:45PM: Run #3

2:45-3:00PM: BREAK

3:00-4:00PM: Afternoon Debrief, Room 100

[End overview of Sept. DAG experiment]

BREAK